

***What Is Claimed Is:***

1. A method of coding a speech or audio signal, comprising the steps of:

- 5 (a) predicting the speech signal to derive a residual signal;
- (b) combining the residual signal with a first noise feedback signal to produce a predictive quantizer input signal;
- (c) predictively quantizing the predictive quantizer input signal to produce a predictive quantizer output signal associated with a predictive quantization noise; and
- 10 (d) filtering the predictive quantization noise to produce the first noise feedback signal.

2. The method of claim 1, wherein said predicting step (a) comprises the steps of:

- 15 (a)(i) predicting the speech signal to produce a predicted speech signal; and
- (a)(ii) combining the predicted speech signal with the speech signal to produce the residual signal.

20 3. The method of claim 2, wherein said predicting step (a)(i) comprises predicting the speech signal based on the speech signal.

4. The method of claim 2, further comprising the step of:

- 25 (e) combining the predictive quantizer output signal with the predicted speech signal to produce a reconstructed speech signal, wherein said predicting step (a)(i) comprises predicting the speech signal based on the reconstructed speech signal.

5. The method of claim 1, wherein:

said predicting step (a) comprises long-term predicting the speech signal; and

said filtering step (d) comprises long-term filtering the predictive quantization noise.

6. The method of claim 1, wherein:

said predicting step (a) comprises short-term predicting the speech signal; and

said filtering step (d) comprises short-term filtering the predictive quantization noise.

7. The method of claim 1, wherein said predicting in step (a) is based on prediction parameters and said filtering in step (d) is based on filter parameters, the method further comprising the step of:

(e) deriving the prediction parameters and the filtering parameters based on the speech signal.

8. The method of claim 1, wherein the speech signal is characterized by short-term and long-term spectral characteristics and coding the speech signal produces a coded speech signal associated with an overall coding noise, said filtering in step (c)(v) comprising one of

short-term filtering the predictive quantization noise, thereby spectrally shaping the overall coding noise to follow the short-term spectral characteristic of the speech signal, and

long-term filtering the predictive quantization noise, thereby spectrally shaping the overall coding noise to follow the long-term spectral characteristic of the speech signal.

9. The method of claim 1, wherein step (c) comprises the steps of:

(c)(i) predicting the predictive quantizer input signal to produce a first predicted predictive quantizer input signal;

(c)(ii) combining the predictive quantizer input signal with at least the first predicted predictive quantizer input signal to produce a quantizer input signal;

(c)(iii) quantizing the quantizer input signal to produce a quantizer output signal; and

(c)(iv) deriving the predictive quantizer output signal based on the quantizer output signal.

10. The method of claim 9, wherein said predicting step (c)(i) comprises short-term predicting the predictive quantizer input signal.

11. The method of claim 10, wherein:

said predicting step (a) comprises long-term predicting the speech signal; and

said filtering step (d) comprises long-term filtering the predictive quantization noise.

12. The method of claim 9, wherein said predicting step (c)(i) comprises long-term predicting the predictive quantizer input signal.

13. The method of claim 12, wherein:

said predicting step (a) comprises short-term predicting the speech signal; and

said filtering step (d) comprises short-term filtering the predictive quantization noise.

14. The method of claim 9, wherein said predicting step (c)(i) is based on prediction parameters, the method further comprising the step of:

deriving the prediction parameters parameters based on the speech signal.

15. The method of claim 9, wherein said quantizing step (c)(iii) comprises scalar quantizing the quantizer input signal.

16. The method of claim 9, wherein said quantizing step (c)(iii) comprises vector quantizing the quantizer input signal.

17. The method of claim 9, wherein said predicting step (c)(i) comprises predicting the predictive quantizer input signal based on the predictive quantizer output signal.

18. The method of claim 9, wherein said deriving step (c)(iv) comprises the step of combining the quantizer output signal with the first predicted predictive quantizer input signal, to derive the predictive quantizer output signal.

19. The method of claim 9, wherein said predicting step (c)(i) comprises predicting the predictive quantizer input signal based on the predictive quantizer input signal.

20. The method of claim 9, wherein said deriving step (c)(iv) comprises the steps of:

predicting the predictive quantizer input signal based on the predictive quantizer output signal, to produce a second predicted predictive quantizer input signal; and

combining the second predictive quantizer input signal with the quantizer output signal to produce the predictive quantizer output signal.

5           21.    The method of claim 9, wherein the quantizer output signal produced in step (c)(iii) is associated with a quantization noise, said predictive quantizing step (c) further comprising the step of:

             (c)(v)   filtering the quantization noise to produce a second noise feedback signal, wherein said combining step (c)(ii) comprises further combining both the predictive quantizer input signal and the first predicted predictive quantizer input signal with the second noise feedback signal, to produce the quantizer input signal.

             22.    The method of claim 21, wherein:  
                      said predicting step (c)(i) comprises short-term predicting the predictive quantizer input signal; and

                      said filtering step (c)(v) comprises short-term filtering the quantization noise.

20           23.    The method of claim 22, wherein:  
                      said predicting step (a) comprises long-term predicting the speech signal; and

                      said filtering step (d) comprises long-term filtering the predictive quantization noise.

25           24.    The method of claim 21, wherein:  
                      said predicting step (c)(i) comprises long-term predicting the predictive quantizer input signal; and

said filtering step (c)(v) comprises long-term filtering the quantization noise.

25. The method of claim 24, wherein:

5       said predicting step (a) comprises short-term predicting the speech signal; and

      said filtering step (d) comprises short-term filtering the predictive quantization noise.

10       26. The method of claim 21, wherein said filtering step (c)(v) is based on filter parameters, the method further comprising the step of:

      deriving the filter parameters based on the speech signal.

15       27. The method of claim 21, wherein the speech signal is characterized by short-term and long-term spectral characteristics and coding the speech signal produces a coded speech signal associated with an overall coding noise, said filtering in step (c)(v) comprising one of

20       short-term filtering the quantization noise, thereby spectrally shaping the overall coding noise to follow the short-term spectral characteristic of the speech signal, and

      long-term filtering the quantization noise, thereby spectrally shaping the overall coding noise to follow the long-term spectral characteristic of the speech signal.

25       28. A method of coding a speech or audio signal, comprising the steps of:

      (a) short-term and long-term predicting the speech signal to produce a short-term and long-term predicted speech signal;

(b) combining the short-term and long-term predicted speech signal with the speech signal to produce a residual signal;

(c) combining the residual signal with a noise feedback signal to produce a quantizer input signal;

5 (d) quantizing the quantizer input signal to produce a quantizer output signal associated with a quantization noise; and

(e) filtering the quantization noise to produce the noise feedback signal.

10 29. The method of claim 28, wherein said filtering step (e) comprises long-term and short-term filtering the quantization noise to produce a short-term and long-term filtered noise feedback signal representing the noise feedback signal.

15 30. The method of claim 28, wherein said predicting step (a) comprises predicting the speech signal based on the speech signal.

31. The method of claim 28, further comprising the step of:

20 (f) combining the quantizer output signal with the predicted speech signal to produce a reconstructed speech signal, wherein said predicting step (a) comprises predicting the speech signal based on the reconstructed speech signal.

25 32. The method of claim 28, wherein the speech signal is characterized by short-term and long-term spectral characteristics and coding the speech signal produces a coded speech signal associated with an overall coding noise, said filtering in step (e) comprising one of

short-term filtering the quantization noise, thereby spectrally shaping the overall coding noise to follow the short-term spectral characteristic of the speech signal, and

long-term filtering the quantization noise, thereby spectrally shaping the overall coding noise to follow the long-term spectral characteristic of the speech signal.

33. An apparatus for coding a speech or audio signal, comprising:  
a first predictor adapted to predict the speech signal so as to derive a residual signal;

a first combiner adapted to combine the residual signal with a first noise feedback signal to produce a predictive quantizer input signal;

a predictive quantizer adapted to predictively quantize the quantizer input signal to produce a predictive quantizer output signal associated with a predictive quantization noise; and

a first filter adapted to filter the predictive quantization noise to produce the first noise feedback signal.

34. The apparatus of claim 33, wherein the first predictor is adapted to produce a predicted speech signal, the apparatus further comprising:

a second combiner adapted to combine the predicted speech signal with the speech signal to produce the residual signal.

35. The apparatus of claim 34, wherein the first predictor is adapted to predict the speech signal based on the speech signal.

36. The apparatus of claim 34, further comprising:  
a third combiner following the predictive quantizer and being adapted to combine the predictive quantizer output signal with the predicted speech



signal to produce a reconstructed speech signal, wherein the first predictor is adapted to predict the speech signal based on the reconstructed speech signal.

37. The apparatus of claim 33, wherein:

5 the first predictor is adapted to long-term predict the speech signal; and  
the first filter is adapted to long-term filter the predictive quantization noise.

38. The apparatus of claim 33, wherein:

10 the first predictor is adapted to short-term predict the speech signal;  
and  
the first filter is adapted to short-term filter the predictive quantization noise.

15 39. The apparatus of claim 33, wherein the first predictor is adapted to predict based on prediction parameters and the first filter is adapted to filter based on filter parameters, the apparatus further comprising:

parameter deriving logic adapted to derive the prediction parameters and the filter parameters based on the speech signal.

20 40. The apparatus of claim 33, wherein the speech signal is characterized by short-term and long-term spectral characteristics and the coding apparatus is adapted to produce a coded speech signal associated with an overall coding noise, the first filter being adapted to perform one of

25 short-term filtering of the predictive quantization noise, thereby spectrally shaping the overall coding noise to follow the short-term spectral characteristic of the speech signal, and

long-term filtering of the predictive quantization noise, thereby spectrally shaping the overall coding noise to follow the long-term spectral characteristic of the speech signal.

5           41.    The apparatus of claim 33, wherein the predictive quantizer comprises:

          a second predictor adapted to predict the predictive quantizer input signal to produce a first predicted predictive quantizer input signal;

          a second combiner adapted to combine the predictive quantizer input signal with the first predicted predictive quantizer input signal to produce a quantizer input signal;

          a quantizer adapted to quantize the quantizer input signal to produce a quantizer output signal; and

          deriving logic adapted to derive the predictive quantizer output signal based on the quantizer output signal.

          42.    The apparatus of claim 41, wherein the second predictor is adapted to short-term predict the predictive quantizer input signal.

20           43.    The apparatus of claim 42, wherein:  
          the first predictor is adapted to long-term predict the speech signal; and  
          the first filter is adapted to long-term filter the predictive quantization noise.

25           44.    The apparatus of claim 41, wherein the second predictor is adapted to long-term predict the predictive quantizer input signal.

          45.    The apparatus of claim 44, wherein:

the first predictor is adapted to short-term predict the speech signal;  
and

the first filter is adapted to short-term filter the predictive quantization  
noise.

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46. The apparatus of claim 41, wherein the second predictor is  
adapted to predict based on prediction parameters, the apparatus further  
comprising:

parameter deriving logic adapted to derive the prediction parameters  
based on the speech signal.

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47. The apparatus of claim 41, wherein the quantizer is a scalar  
quantizer adapted to scalar quantize the input signal.

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48. The apparatus of claim 41, wherein the quantizer is a vector  
quantizer adapted to vector quantize the input signal.

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49. The apparatus of claim 41, wherein the second predictor is  
adapted to predict the predictive quantizer input signal based on the predictive  
quantizer output signal.

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50. The apparatus of claim 41, wherein the deriving logic includes  
a third combiner following the quantizer and being adapted to combine the  
quantizer output signal with the first predicted predictive quantizer input  
signal to derive the predictive quantizer output signal.

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51. The apparatus of claim 41, wherein the second predictor is  
adapted to predict the predictive quantizer input signal based on the predictive  
quantizer input signal.

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52. The apparatus of claim 41, wherein the deriving logic comprises:

5 a third predictor following the quantizer and being adapted to predict the predictive quantizer input signal based on the predictive quantizer output signal, to produce a second predicted predictive quantizer input signal; and

a third combiner following the quantizer and being adapted to combine the second predictive quantizer input signal with the quantizer output signal to produce the predictive quantizer output signal.

53. The apparatus of claim 41, wherein the quantizer output signal produced by the quantizer is associated with a quantization noise, the predictive quantizer further comprising:

10 a second filter adapted to filter the quantization noise to produce a second noise feedback signal; and

15 a combining arrangement adapted to combine the second noise feedback signal with both the predictive quantizer input signal and the first predicted predictive quantizer input signal, to produce the quantizer input signal.

20 54. The apparatus of claim 53, wherein:

the second predictor is adapted to short-term predict the predictive quantizer input signal; and

the second filter is adapted to short-term filter the quantization noise.

25 55. The apparatus of claim 54, wherein:

the first predictor is adapted to long-term predict the speech signal; and

the first filter is adapted to long-term filter the predictive quantization noise.

56. The apparatus of claim 53, wherein:

the second predictor is adapted to long-term predict the predictive quantizer input signal; and

the second filter is adapted to long-term filter the quantization noise.

57. The apparatus of claim 54, wherein:

the first predictor is adapted to short-term predict the speech signal; and

the first filter is adapted to short-term filter the predictive quantization noise.

58. The apparatus of claim 53, wherein the second filter is adapted to filter based on filter parameters, the apparatus further comprising:

parameter deriving logic adapted to derive filter parameters based on the speech signal.

59. The apparatus of claim 53, wherein the speech signal is characterized by short-term and long-term spectral characteristics and the coding apparatus is adapted to produce a coded speech signal associated with an overall coding noise, the second filter being adapted to perform one of

short-term filtering of the quantization noise, thereby spectrally shaping the overall coding noise to follow the short-term spectral characteristic of the speech signal, and

long-term filtering of the quantization noise, thereby spectrally shaping the overall coding noise to follow the long-term spectral characteristic of the speech signal.

60. An apparatus for coding a speech or audio signal, comprising:

a predictor adapted to short-term and long-term predict the speech signal to produce a short-term and long-term predicted speech signal;

a first combiner adapted to combine the short-term and long-term predicted speech signal with the speech signal to produce a residual signal;

5 a second combiner adapted to combine the residual signal with a noise feedback signal to produce a quantizer input signal;

a quantizer adapted to quantize the quantizer input signal to produce a quantizer output signal associated with a quantization noise; and

10 a filter adapted to filter the quantization noise to produce the noise feedback signal.

61. The apparatus of claim 60, wherein the filter is adapted to long-term and short-term filter the quantization noise to produce a short-term and long-term filtered noise feedback signal representing the noise feedback signal.

62. The apparatus of claim 60, wherein the first predictor is adapted to predict the speech signal based on the speech signal.

20 63. The apparatus of claim 60, further comprising:  
a third combiner following the quantizer and being adapted to combine the quantizer output signal with the predicted speech signal to produce a reconstructed speech signal, wherein the predictor is adapted to predict the speech signal based on the reconstructed speech signal.

25 64. The apparatus of claim 60, wherein the speech signal is characterized by short-term and long-term spectral characteristics and the coding apparatus produces a coded speech signal associated with an overall coding noise, the first filter being adapted to perform one of

short-term filtering of the quantization noise, thereby spectrally shaping the overall coding noise to follow the short-term spectral characteristic of the speech signal, and

long-term filtering of the quantization noise, thereby spectrally shaping the overall coding noise to follow the long-term spectral characteristic of the speech signal.

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2025 RELEASE UNDER E.O. 14176